# An Examination of the Association of Multiple Acculturation Measures with Asthma Status Among Elementary School Students in El Paso, Texas

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## BACKGROUND

Variations in the prevalence of lifetime asthma by race and/or ethnicity and within Hispanic subgroups are well documented. [1] The Centers for Disease Control and Prevention estimates a prevalence of current asthma, whereby a person has been diagnosed with asthma and reports still having it, [2] of 9.6% among Hispanics compared to 7.8% among non-Hispanic White patients under the age of 18 years. Within the Hispanic population, which includes immigrants from Mexico, Puerto Rico, Cuba, Central and South America and their descendants, regardless of race, rates are as high as 24.8% among those of Puerto Rican descent and as low as 7.8% among those of Mexican descent. [3]

The striking variations in the prevalence of asthma by Hispanic subgroup have prompted efforts to broaden understanding of micro- and macro-level factors driving these differences. The Hispanic epidemiologic paradox (HEP), [4] a term first coined in the mid-1980s to describe the contradiction whereby individuals of Mexican descent have better health outcomes than their US-counterparts, despite experiencing poorer socioeconomic conditions, is often used to shed light on variations in outcomes. Sometimes used interchangeably with the *Latino epidemiologic paradox*, *Latino mortality paradox*, or *Immigrant paradox*, researchers have applied the HEP to a myriad of outcomes including, but not limited to, mortality rates, [5] low birth weight, [6] mental health, [7] and asthma. [8] Investigators have consistently observed better outcomes among immigrants compared to their US-counterparts initially, and to a lesser extent over time, in the US. In line with the HEP, researchers have generated substantial research in the area of acculturation, a process whereby members of a cultural group may adopt the norms of another,[9] as a means to elucidate the factors that contribute to these better health outcomes and the point at which they no longer confer a protective effect. [10–12]

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Prior scholarship examining acculturation and diagnosed asthma demonstrates lower rates of asthma among Mexico-born Mexican-Americans than their US-counterparts. [13,14] Some researchers posit that the lower prevalence among those of Mexican descent may result from under-diagnosis of asthma symptoms [15] rather than an absence of illness. In the early 1980's, Dodge's examination of respiratory health differences between Mexican-American and non-Mexican-American White children identified a higher rate of physician-diagnosed asthma among non-Mexican-American than Mexican-American school children (6.5% vs 1.9%), despite similar rates of asthma symptoms. [16] Indeed, the body of research to date suggests that asthma is under-diagnosed and undertreated. [17–19] In the United States, prevalence estimates for undiagnosed asthma, wherein symptoms are present but a diagnosis has not been established, vary by race/ethnicity as well as geography, notably urban vs. rural residence. [15,20–25] A 2007 report from the American Thoracic Society approximates "that the prevalence of undiagnosed asthma in children ranges from 3 to 20%." [26] This raises concerns about an underestimated burden of disease, particularly among high-risk underserved populations, in whom extrinsic factors may impede the assessment of symptoms, subsequent diagnosis, and initiation of treatment. [27]

Whereas the influence of factors associated with the prevalence of asthma is well established, [28,29] less established is the influence of factors associated with undiagnosed asthma, and even less so, cultural aspects that may promote or impede diagnosis. Some authors looking at parental language and the likelihood of receiving an asthma diagnosis point to possible underdiagnosis of asthma among Spanish-speaking respondents compared to English-speaking respondents, [30] while others describe that nativity (foreign-birth) confers a protective effect against asthma, an effect that diminishes with duration in the US. [31,32] Among Mexican-Americans in particular, some researchers recommend that nativity as well as acculturation be considered risk factors for asthma. [13,14] However, ambiguity about what acculturation means and how it is measured has led some to question its use in health research, [33,34] as defining acculturation as a singular construct, one measured by language or nativity alone, is inherently challenging. [35]

Traditionally, proxies for acculturation include static, unidimensional measures like nativity, immigrant status, years in the country, and language use. [9,36] More nuanced, multidimensional measures of acculturation that tap into behaviors, values, and cultural preferences, are less common given their complexity. [37] Capturing these measures is important, as they can provide insight into differences in prevalence estimates that could otherwise be missed. For instance, differences in health outcomes like childhood obesity [38] and health behaviors like dietary fiber intake, have been observed to differ by level of acculturation. [39]

At a minimum, undiagnosed asthma can negatively impact school attendance, academic achievement, and social functioning, particularly if symptoms are uncontrolled. [23] Despite estimates of lower asthma rates among Mexicans and those of Mexican descent overall, evidence of a higher prevalence of asthma among US-born compared to Mexico-born Mexican-Americans is growing. [13,14,40] There is also evidence of increased asthma hospitalizations among US-Mexico border children compared to non-border children, [41,42]

which is reflective of poorly controlled asthma, and underscores the need to critically appraise factors like acculturation, and its influence on asthma in this area.

The US-Mexico border region allows for a unique opportunity to examine associations of asthma prevalence with measures of acculturation, and decipher whether patterns in asthma status exist. This study aims to determine the frequency and characteristics of asthma status (no wheezing/asthma symptoms, possible undiagnosed asthma, and diagnosed asthma) among a population of elementary school-aged children in the El Paso Independent School District (Texas, USA), as well as identify and compare measures of acculturation associated with asthma status, controlling for sociodemographic factors among the children. These multivariate analyses of possible undiagnosed asthma extend previous research by including both traditional unidimensional proxies for acculturation, and a theory-based multidimensional measure of acculturation. Combined, these may support novel insight into potential patterns of asthma status.

## Theoretical and Conceptual Framework

We drew on some elements from Canino et al.'s Conceptual Framework of Pediatric Asthma Disparities to inform our work and the selection of relevant covariates. [43] This conceptual framework delineates four multifaceted and interconnected domains that influence disparities in the prevalence, morbidity, and severity of asthma among Latino children: individual characteristics, the environment, the healthcare system, and provider's characteristics. In line with this framework, we focus on the domains of the individual (e.g., age, gender, acculturation), and the health care system (e.g., insurance coverage), to better understand disparities in asthma (e.g., diagnosed and undiagnosed asthma burden) among this group of Latino children.

## Methods

### Participants

Data were collected through the Environment Core of the Hispanic Health Disparities Research Center at the University of Texas, El Paso (UTEP), which carried out a cross-sectional study aimed at examining inequities in the respiratory health of elementary school children in the US-Mexico border region of El Paso County (EPC).[43] The expanded examination of acculturation strategies from these data, which are the focus of the current study, have not been previously investigated. EPC is located in the US-Mexico border region, which stretches over 2,000 miles from California to Texas and is home to an underserved population that is expected to reach 9.8 million by 2020. [44] In 2012, approximately 82% of EPC's 827,398 residents identified as Hispanic; approximately 78% of these identified as of Mexican descent in particular. [45] The median household income of county residents ($40,157) was lower than that of the State of Texas ($51,900) and the United States ($53,046). In line with these estimates, 23.3% of persons were below poverty level in EPC, compared to 17.6% in the State of Texas, and 15.4% in the United States. [46] The population for these analyses consists of Hispanic students of Mexican descent enrolled at El Paso Independent School District (EPISD), which is the largest school district in EPC.

### Data Collection

In May of 2012, all households of 4th and 5th grade students enrolled at EPISD (n=6,295) were mailed a survey packet in English and Spanish by a team of researchers at UTEP. [47–53] The survey packet included a close-ended questionnaire, consent form, postage-paid return envelope and $2 token of appreciation. A follow-up bilingual reminder postcard was mailed a week later. All non-respondents received another survey packet the following week, resulting in final response rate of 30.2% (1,904/6,295). Household surveys with similar response rates have been shown to be representative of target populations. [54–58] Descriptive statistics demonstrated that the demographic characteristics of this group of 4th and 5th grade students at EPISD are similar to those of the student population throughout EPISD. [59] The protocol for the parent study was approved by the Institutional Review Board (IRB) at the University of Texas, El Paso. The questionnaire made explicit that completing and returning the survey to the study research team established informed consent to participate. All questionnaires were reviewed by UTEP data managers for completeness and to ensure accuracy of participant responses. The protocol for this current study was approved by the Institutional Review Board (IRB) at the University of Texas, School of Public Health (UTSPH IRB). For the purposes of this work, we restricted our sample to Hispanic students of Mexican descent (n=1,305).

### Measures

The study instrument included questions about age, race/ethnicity, nativity, language use, income, education, health insurance, acculturation and the child's respiratory history. [50] The latter included caretaker report of physician diagnosed asthma, asthma symptoms, and treatment in line with the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire, a valid instrument for determining asthma symptoms in the past 12 months. [60] The ISAAC questionnaire has been found to have sensitivity and specificity of 0.85 (0.73–0.93) and 0.81 (0.76–0.86), respectively, as well as test-retest reproducibility. [61]

**Dependent and Independent Variables**—The primary outcome variable was asthma status (0=no wheezing or no asthma symptoms, 1=possible undiagnosed asthma, and 2=diagnosed asthma), ascertained from primary caretaker responses on the ISAAC questionnaire. [61] Specifically, a negative report of wheezing/asthma symptoms (coughing, wheezing or whistling in the chest, shortness of breath, chest tightness or phlegm when one does not have a cold or respiratory infection) currently or in the last 12-months, and no physician diagnosis, was used to categorize students with no wheezing/no asthma symptoms. Affirmative reporting of the aforementioned symptoms without a physician diagnosis was used to indicate possible undiagnosed asthma; affirmative reporting of "Has the child ever been told by a doctor or other health professional that he or she has asthma?" was used to categorize students diagnosed with asthma.

The primary independent variables were measures of acculturation as reported by the primary caretaker about the child. Unidimensional measures, including aspects of nativity and preferred language use, have all been associated with diagnosed and possible undiagnosed asthma status. [30,40,62] Birthplace and language are important predictors of asthma among Mexican-American populations and often used as proxies for immigration

and acculturation. [30,63] We included nativity and survey language used as dichotomous variables (1=US-born, 0=foreign-born; 1=English, 0=Spanish). The multidimensional measure of acculturation was operationalized using the shortened version of Mendoza's Cultural Life Style Inventory (CLSI) with acculturation categories for Mexican oriented (segregation), multicultural oriented (integration), US oriented (assimilation), and non-dominant/eclectic. [64,65] Evidence of the validity and reliability of the 11-item CLSI has been documented, with a Cronbach's alpha to assess internal consistency reliability of $\alpha$ =.92. [66] This acculturation inventory includes items on the language and social preferences of participants, as well as preferences for the celebration of cultural holidays. For instance, language preferences when reading, writing, thinking, and/or speaking within and outside the home; language preferences related to media, prayer and social interactions; preferences for the celebration of cultural holidays, and the preferred term for identification. The five-point Likert scale for the language items includes: only Spanish, more Spanish than English, both equally, more English than Spanish, or English only. Related to social preferences, items include preferences to engage always with Hispanics, mostly with Hispanics, both with non-Hispanics and Hispanics about equally, mostly with non-Hispanics, always with non-Hispanics. Preferences for the celebration of cultural holidays include: only Mexican holidays, mostly Mexican holidays, both American (US) and Mexican holidays about equally, mostly American (US) holidays, only American (US) holidays; other (specify); do not celebrate any national or cultural holidays. Responses for the CLSI items were scored to correspond with Mendoza's suggested categories for dominant oriented acculturation, whereby segregated individuals gravitate toward Mexican culture, assimilated individuals gravitate toward those of the mainstream US culture, integrated individuals maneuver both cultures without clear preference, and non-dominant/eclectic individuals exhibit no clear acculturation pattern. [66,67] All 11-items were coded to correspond to a "0" if not answered or a "1" if answered. All items were summed and divided by the total number of items answered, resulting in proportions for each of three categories between 0 and 1. Respondents were categorized according to their dominant typology in line with the category that included their highest proportion, as recommended by Mendoza. [67] For instance, a respondent with a segregation proportion of 0.18, an integration proportion of 0.72, and an assimilation proportion of .09 would be categorized as *"integrated"* with integrated =1, segregated=0, and assimilated=0. Tied scorers with no clear acculturation pattern (non-dominant/eclectic) were excluded from these analyses (7.7%).

**Covariates—**The selection of covariates was based on prior literature and the availability of data. Proxies for socioeconomic status included the whether the child had a regular doctor for routine medical care (1=yes, 0=no) and whether the family postponed or did not seek medical treatment due to problems with cost in the last year (1=yes, 0=no). [68] Additional variables examined due to their association with an increased risk of asthma included: gender (1=male, 0=female), the child's history of allergies (1=yes, 0=no), and insurance coverage in the last year (1=yes, 0=no). Age ranged from 9–13 in this group of 4th and 5th grade students. Descriptive statistics indicated that age-adjustment was not needed in these analyses.

### Analyses

We performed bivariate associations between the child's asthma status (no wheezing/asthma symptoms, possible undiagnosed asthma, diagnosed asthma) and variables of interest using chi-square and Fisher's exact tests for categorical variables and t-tests for normally distributed continuous variables. Missing data were excluded from these analyses (see Table 1), and complete case analyses were performed for all analyses.

Multinomial logistic regression models were estimated to test the association between the child's asthma status (with no wheezing/asthma symptoms as referent group) and acculturation measures (nativity, language, CLSI category). Our first model (n=1,095) included gender, history of allergies, insurance coverage, whether the child has a regular doctor for routine care, and whether the family postpones or does not seek medical treatment due to cost (model 1). Subsequent models included nativity (model 2), language (model 3), and CLSI category (model 4), entered separately. Multi-collinearity was assessed using the variance inflation factor (VIF); values greater than 10 were removed from the models. Results are presented as relative risk ratios (RRs) and corresponding 95% confidence intervals (CIs). Statistical significance is measured as a p-value of .05 or less. Statistical analyses were conducted using STATA® version 12 (STATA Corp., TX, USA).

## Results

### Descriptive Statistics

Table 1 displays the characteristics of the study population of Hispanic children of Mexican descent (n=1,305). Possible undiagnosed asthma was reported for 9% of children in this group, whereas lifetime asthma prevalence was reported for approximately 15% of children; 76% of children in this sample did not experience wheezing or asthma symptoms. Combined, the results of this study indicate that total burden of asthma (possible undiagnosed and diagnosed asthma) is about 24%. Over 83% of students had continuous insurance coverage over the 12-month period prior to the administration of this survey and 90% described having a regular doctor for routine care, however, almost a third of the population described having postponed or not sought medical treatment due to problems with cost.

### Acculturation Measures

Over 90% of the study population was born in the United States and 55% of primary caretakers responded to the English version of the study instrument. Almost sixty percent of students were classified as assimilated, 27% were classified as segregated and 14% were classified as integrated, per Mendoza's CLSI categories (Table 1). Bivariate analyses (Table 2) showed significant associations for asthma status and our acculturation measures. A higher proportion of those classified as segregated (gravitate toward Mexican culture) or as integrated (maneuver between Mexican and US cultures) reported not having wheezing or asthma symptoms in the last year, whereas a higher proportion of those classified as assimilated (gravitate toward US culture) did experience wheezing or asthma symptoms in the last year. Specifically, we found that the relative risk of possible undiagnosed asthma was significantly higher among children whose parents completed the survey in English (RR:

1.9, 95% CI: 1.3–2.9) and among assimilated children (RR: 2.2–95% CI: 1.3–3.7), compared to children with no wheezing/asthma symptoms.

The relative risk of possible undiagnosed asthma was not significantly higher among children born in the US (RR: 1.6–95% CI: 0.7–3.3), compared to children with no wheezing/ asthma symptoms. The relative risk of diagnosed asthma was significantly higher among US-born children (RR: 3.0–95% CI: 1.4–6.6), children whose parents completed the survey in English (RR: 1.6–95% CI: 1.1–2.2), and assimilated children (RR: 2.1–95% CI: 1.4–3.3), compared to children with no wheezing/asthma symptoms.

**Multivariate Analyses—**Relative risk ratios for the multinomial logit models of asthma status are shown in Table 3. Model 1 shows that the relative risk of possible undiagnosed asthma was higher for children with a history of allergies (RR: 4.7, p<0.01) and children from families who postpone care due to cost (RR: 2.07, p<0.01), compared to those with no wheezing/asthma symptoms, holding other model variables constant. The relative risk of possible undiagnosed asthma was lower among children who have a doctor for routine care (RR: 0.89, NS). The relative risk of possible undiagnosed asthma was not significantly different between US- and foreign-born children (model 2). We did observe a marginally significant higher relative risk of undiagnosed asthma among children whose parents took the survey in English (RR: 1.58, p <0.1) (model 3). Model 4 shows no significant difference by acculturation category.

Similarly, the relative risk of diagnosed asthma was higher for boys (RR: 1.79, p<0.01), children with a history of allergies (RR: 6.7, p<0.01), children who have a doctor for routine care (RR: 3.11, p<0.05), and children from families who postpone care due to cost (RR: 1.71, p<0.05), compared to those with no wheezing/asthma symptoms, holding other model variables constant. We did not observe significant differences by nativity (model 2) or language (model 3). We did observe a marginally significant higher relative risk of diagnosed asthma among assimilated children (RR: 1.55, p<0.1).

## Discussion

Incorporating unidimensional and multidimensional measures of acculturation in assessments of asthma status can reveal important relationships that could otherwise be missed. Few studies have examined factors associated with the burden of possible undiagnosed asthma. Fewer still have examined these factors along with well-defined acculturation measures that take into account more than language use, nativity or years in the United States, as traditionally, unidimensional constructs of acculturation are used. [21,40]

Our bivariate analyses showed significant associations between asthma status and all measures of acculturation (p <0.05). In terms of nativity, a higher proportion of children with no wheezing/asthma symptoms were born outside of the US, whereas a higher proportion of students with possible diagnosed asthma and diagnosed asthma, respectively, were US-born. We found a similar pattern with language and CLSI category: a higher proportion of children whose parents took the survey in Spanish did not have wheezing/ asthma symptoms, whereas a higher proportion of children whose parents took the survey in

English did have wheezing/asthma symptoms; a higher proportion of children with no wheezing/asthma symptoms were classified as segregated (i.e., connected more strongly with Mexican culture), a higher proportion of students with symptoms were classified as integrated/assimilated.

In our multivariate analyses, nativity was not significantly associated with possible undiagnosed asthma or diagnosed asthma compared to no wheezing/asthma symptoms, however, language and CLSI category were marginally significant for possible undiagnosed asthma and diagnosed asthma, respectively (p<0.1). While prior scholarship describes that foreign birth has been associated with undiagnosed asthma as well as lower odds of reporting diagnosed asthma, we did not find statistically significant differences in this sample. [62, 69–71] Related to language, children whose parent took the survey in English were more likely to have possible undiagnosed asthma than children whose parent took the survey in Spanish, although not significantly. In their analysis of language and asthma status among Hispanic school children in Chicago, Mosnaim and colleagues report higher rates of asthma among children of parents who completed questionnaires in English, and posit that an under diagnosis of asthma may be related to parental preference for Spanish communication. [30] This is the opposite of what we found here. In our case, the majority of Spanish-speaking children have no symptoms (81% vs. 71% of English-speaking children, data not shown), which may relate to why children from English-speaking families have higher relative risk of undiagnosed asthma.

In terms of the acculturation categories, there was no statistically significant difference in the relative risk of undiagnosed asthma for integrated or assimilated vs. segregated children. This suggests that children who identify strongly with Mexican culture were more likely to be undiagnosed than children who identify with both Mexican and US culture. This finding is somewhat related to Eldeirawi et al., who found a higher likelihood of asthma among highly acculturated Mexican-Americans (OR=2.57, 95%CI: 1.58–4.19) compared to their lower acculturated counterparts. [63] In terms of why the acculturation findings were not significant, there are several possible reasons. One explanation relates to the Hispanic Health Paradox and the very low rates of asthma symptoms and wheezing reported by immigrant children and children from immigrant families.[50] Another reason may relate to the location of the study on the US-Mexico border. Acculturation, language preferences and nativity may be less important in shaping a child's relative risk of remaining undiagnosed, when the majority of people in the community speak Spanish and are comfortable in the Mexican culture. A previous study found that acculturation was closely related to having an asthma diagnosis vs not having a diagnosis,[51] suggesting that those factors do matter in some ways. It is clear that culture-related axes are not driving disparities in undiagnosed asthma among this sample of Hispanic children. Instead, access to care seems to be more important since our results reveal a lower relative risk of possible undiagnosed asthma among those with a regular doctor for routine care (RR: 0.26; 95% CI: 0.1–0.9, not shown), compared to diagnosed asthma. Further information is required as to the means by which measures of acculturation can impact respiratory health. While one of the key strengths of this study is the level of detail from measures included in the study instrument, this is also one of its key limitations. The data for this analysis were obtained from a self-administered questionnaire

about the child's language and social preferences. It is possible that the respondent's perception of the child's preferences differ from those of the child's.

The most important finding from this study is not related to acculturation and instead relates to the high burden of asthma uncovered in this analysis: the prevalence of possible undiagnosed asthma is 9% and that of diagnosed asthma is 15%; combined, these estimates show that almost a quarter of this population is experiencing some respiratory distress. Our findings are congruent with those of Shalowitz and colleagues in Chicago, who identified a total potential burden of asthma of about 25%. [72] Studies examining racial and ethnic disparities of diagnosed and undiagnosed asthma, for example, Quinn et al., have found more children (14.5%) with respiratory symptoms consistent with possible asthma, than had diagnosed asthma (12.2%), [15] supporting the notion that asthma may be under-diagnosed. In our sample, we found a prevalence of possible undiagnosed asthma closer to that expected for diagnosed asthma, suggesting that indeed, asthma may be under-diagnosed.

## CONCLUSION

Examining contextual factors associated with asthma status among US-Mexico border children presents an opportunity to disentangle the influence of such factors on the burden of illness experienced by this population. There remains a need to better assess the health status and outcomes of a burgeoning population with health problems that may be masked by social or cultural factors. In line with scholarship on the influence of race/ethnicity on health outcomes, where the social and economic effects that the construct of race/ethnicity has on outcomes may mask associations, [73] a similar pattern may occur with acculturation. However, it is also important to consider that capturing acculturation on the border may not be as informative as in other areas. The current study advances previous work with a broadly representative group of Hispanic schoolchildren throughout El Paso County using a validated asthma survey for previously diagnosed asthma and possible undiagnosed asthma as well as more fine-tuned measures for acculturation to evaluate potential disparities. Future studies would benefit from the inclusion of qualitative interviews with representative sample of the study population of interest to assess aspects of acculturation and tease out differences among those grouped into a given acculturation category. Including measures that allow primary caretaker to describe their definition of wheezing and/or asthma may reveal whether self-report is in fact lower or whether the severity is not deemed urgent enough to warrant reporting by the primary caretaker.

The Hispanic population in the U.S. is growing at an astounding rate. With the shift in the population – from foreign-born to a largely U.S.-born – comes the opportunity to continue examining how acculturation impacts health outcomes. In the case of Mexican-Americans in particular, the largest Hispanic subgroup, it remains to be seen whether the lower levels of asthma observed now will continue in ensuing generations -- or whether an under diagnosis may lead to an increased burden of disease over time.

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## References

1. Lara M, Akinbami L, Flores G, Morgenstern H. Heterogeneity of childhood asthma among hispanic children: Puerto rican children bear a disproportionate burden. Pediatrics. 2006; 117(1):43–53. [PubMed: 16396859]

2. Akinbami LJ. The state of childhood asthma, united states. CDC Advanced Data and Vital Statistics. 2006

3. Centers for Disease Control and Prevention (CDC). Vital signs: Asthma prevalence, disease characteristics, and self-management education: United states, 2001--2009. MMWR Morb Mortal Wkly Rep. 2011; 60(17):547–552. [PubMed: 21544044]

4. Markides KS, Coreil J. The health of hispanics in the southwestern united states: An epidemiologic paradox. Public Health Rep. 1986; 101(3):253–265. [PubMed: 3086917]

5. Abraido-Lanza AF, Dohrenwend BP, Ng-Mak DS, Turner JB. The latino mortality paradox: A test of the "salmon bias" and healthy migrant hypotheses. Am J Public Health. 1999; 89(10):1543–1548. [PubMed: 10511837]

6. Fuentes-Afflick E, Lurie P. Low birth weight and latino ethnicity: Examining the epidemiologic paradox. Arch Pediatr Adolesc Med. 1997; 151(7):665–674. [PubMed: 9232039]

7. Alegria M, Canino G, Shrout PE, et al. Prevalence of mental illness in immigrant and non-immigrant US latino groups. Am J Psychiatry. 2008; 165(3):359–369. [PubMed: 18245178]

8. Cagney KA, Browning CR, Wallace DM. The latino paradox in neighborhood context: The case of asthma and other respiratory conditions. Am J Public Health. 2007; 97(5):919–925. [PubMed: 17395846]

9. Padilla AM. Acculturation, theory, models, and some new findings. Advancement of Science. 1980

10. Hazuda HP, Haffner SM, Stern MP, Eifler CW. Effects of acculturation and socioeconomic status on obesity and diabetes in mexican americans. the san antonio heart study. Am J Epidemiol. 1988; 128(6):1289–1301. [PubMed: 3195568]

11. Cobas JA, Balcazar H, Benin MB, Keith VM, Chong Y. Acculturation and low-birthweight infants among latino women: A reanalysis of HHANES data with structural equation models. Am J Public Health. 1996; 86(3):394–396. [PubMed: 8604766]

12. Valencia-Garcia D, Simoni JM, Alegría M, Takeuchi DT. Social capital, acculturation, mental health, and perceived access to services among mexican american women. J Consult Clin Psychol. 2012; 80(2):177. [PubMed: 22329824]

13. Holguin F, Mannino DM, Antó J, et al. Country of birth as a risk factor for asthma among mexican americans. American journal of respiratory and critical care medicine. 2005; 171(2):103–108. [PubMed: 15516539]

14. Eldeirawi KM, Persky VW. Associations of acculturation and country of birth with asthma and wheezing in mexican american youths. Journal of Asthma. 2006; 43(4):279–286. [PubMed: 16809241]

15. Quinn K, Shalowitz MU, Berry CA, Mijanovich T, Wolf RL. Racial and ethnic disparities in diagnosed and possible undiagnosed asthma among public-school children in chicago. Am J Public Health. 2006; 96(9):1599–1603. [PubMed: 16507720]

16. Dodge R. A comparison of the respiratory health of mexican-american and non-mexican-american white children. CHEST Journal. 1983; 84(5):587–592.

17. Speight AN. Is childhood asthma being underdiagnosed and undertreated? Br Med J. 1978; 2(6133):331–332. [PubMed: 99203]

18. Speight AN, Lee DA, Hey EN. Underdiagnosis and undertreatment of asthma in childhood. Br Med J (Clin Res Ed). 1983; 286(6373):1253–1256.

19. Siersted HC, Boldsen J, Hansen HS, Mostgaard G, Hyldebrandt N. Population based study of risk factors for underdiagnosis of asthma in adolescence: Odense schoolchild study. BMJ. 1998; 316(7132):651–5. discussion 655–6. [PubMed: 9522784]

20. Yeatts K, Davis KJ, Sotir M, Herget C, Shy C. Who gets diagnosed with asthma? frequent wheeze among adolescents with and without a diagnosis of asthma. Pediatrics. 2003; 111(5):1046–1054. [PubMed: 12728087]

21. Magzamen S, Tager IB. Factors related to undiagnosed asthma in urban adolescents: A multilevel approach. Journal of Adolescent Health. 2010; 46(6):583–591. [PubMed: 20472216]

22. Bryant-Stephens T. Asthma disparities in urban environments. J Allergy Clin Immunol. 2009; 123(6):1199–1206. [PubMed: 19501229]

23. Perry TT, Vargas PA, McCracken A, Jones SM. Underdiagnosed and uncontrolled asthma: Findings in rural schoolchildren from the delta region of arkansas. Annals of Allergy, Asthma & Immunology. 2008; 101(4):375–381.

24. Wolf RL, Berry CA, Quinn K. Development and validation of a brief pediatric screen for asthma and allergies among children. Annals of Allergy, Asthma & Immunology. 2003; 90(5):500–507.

25. Wolf RL, Berry CA, O'Connor T, Coover L. Validation of the brief pediatric asthma screen. CHEST Journal. 1999; 116(suppl_2):224S–229S.

26. Gerald LB, Sockrider MM, Grad R, et al. An official ATS workshop report: Issues in screening for asthma in children. Proceedings of the American Thoracic Society. 2007; 4(2):133–141. [PubMed: 17494724]

27. Maier WC, Arrighi HM, Morray B, Llewllyn C, Redding GJ. The impact of asthma and asthma-like illness in seattle school children. J Clin Epidemiol. 1998; 51(7):557–568. [PubMed: 9674662]

28. Litonjua AA, Carey VJ, Weiss ST, Gold DR. Race, socioeconomic factors, and area of residence are associated with asthma prevalence. Pediatr Pulmonol. 1999; 28(6):394–401. [PubMed: 10587412]

29. Andrew Aligne C, Auinger P, Byrd RS, Weitzman M. Risk factors for pediatric asthma: Contributions of poverty, race, and urban residence. American Journal of Respiratory and Critical Care Medicine. 2000; 162(3):873–877. [PubMed: 10988098]

30. Mosnaim GS, Sadowski LS, Durazo-Arvizu RA, et al. Parental language and asthma among urban hispanic children. J Allergy Clin Immunol. 2007; 120(5):1160–1165. [PubMed: 17983874]

31. Joseph SP, Borrell LN, Shapiro A. Self-reported lifetime asthma and nativity status in US children and adolescents: Results from the national health and nutrition examination survey 1999–2004. J Health Care Poor Underserved. 2010; 21(2):125–139. [PubMed: 20453381]

32. Eldeirawi KM, Persky VW. Associations of physician-diagnosed asthma with country of residence in the first year of life and other immigration–related factors: Chicago asthma school study. Annals of Allergy, Asthma & Immunology. 2007; 99(3):236–243.

33. Hunt LM, Schneider S, Comer B. Should "acculturation" be a variable in health research? A critical review of research on US hispanics. Soc Sci Med. 2004; 59(5):973–986. [PubMed: 15186898]

34. Thomson MD, Hoffman-Goetz L. Defining and measuring acculturation: A systematic review of public health studies with hispanic populations in the united states. Soc Sci Med. 2009; 69(7):983–991. [PubMed: 19525050]

35. Horevitz E, Organista KC. The mexican health paradox expanding the explanatory power of the acculturation construct. Hispanic Journal of Behavioral Sciences. 2013; 35(1):3–34.

36. Lara M, Gamboa C, Kahramanian MI, Morales LS, Hayes Bautista DE. Acculturation and latino health in the united states: A review of the literature and its sociopolitical context. Annu Rev Public Health. 2005; 26:367–397. [PubMed: 15760294]

37. Abraído-Lanza AF, Armbrister AN, Flórez KR, Aguirre AN. Toward a theory-driven model of acculturation in public health research. Am J Public Health. 2006; 96(8):1342–1346. [PubMed: 16809597]

38. Elder JP, Arredondo EM, Campbell N, et al. Individual, family, and community environmental correlates of obesity in latino elementary school children. J Sch Health. 2010; 80(1):20–30. [PubMed: 20051087]

39. Ayala GX, Baquero B, Arredondo EM, Campbell N, Larios S, Elder JP. Association between family variables and mexican american children's dietary behaviors. Journal of Nutrition Education and Behavior. 2007; 39(2):62–69. [PubMed: 17346653]

40. Martin MA, Shalowitz MU, Mijanovich T, Clark-Kauffman E, Perez E, Berry CA. The effects of acculturation on asthma burden in a community sample of mexican american schoolchildren. Am J Public Health. 2007; 97(7):1290–1296. [PubMed: 17538053]

41. English PB, Von Behren J, Harnly M, Neutra RR. Childhood asthma along the united states/mexico border: Hospitalizations and air quality in two california counties. Revista Panamericana de Salud Pública. 1998; 3(6):392–399. [PubMed: 9734219]

42. Grineski S. Characterizing children's asthma hospitalizations on the texas–mexico border. Journal of asthma. 2007; 44(9):783–787. [PubMed: 17994411]

43. Canino G, Koinis-Mitchell D, Ortega AN, McQuaid EL, Fritz GK, Alegría M. Asthma disparities in the prevalence, morbidity, and treatment of latino children. Soc Sci Med. 2006; 63(11):2926–2937. [PubMed: 16956704]

44. United States-Mexico Border Health Commission. Border lives: Health status in the united states-mexico border region. United States-Mexico Border Health Commission; 2010.

45. U.S. Census Bureau. [Accessed October 28th 2016] American Community Survey. B0300101: Hispanic or latino origin by specific origin. 2010–2012. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_12_3YR_B03001&prodType=table

46. U.S. Census Bureau's American Community Survey Office. [Accessed December 1 2014, 2014] American FactFinder. "S1701: Poverty status in the past 12 months". 2012 american community survey. 2012. http://www.census.gov/quickfacts/table/IPE120213/48141,00,48

47. Kim Y, Collins TW, Grineski SE. Neighborhood context and the hispanic health paradox: Differential effects of immigrant density on children' s wheezing by poverty, nativity and medical history. Health Place. 2014; 27:1–8. [PubMed: 24509419]

48. Collins TW, Kim Y, Grineski SE, Clark-Reyna S. Can economic deprivation protect health? paradoxical multilevel effects of poverty on hispanic children's wheezing. International journal of environmental research and public health. 2014; 11(8):7856–7873. [PubMed: 25101769]

49. Grineski SE, Collins TW, Olvera HA. Local variability in the impacts of residential particulate matter and pest exposure on children's wheezing severity: A geographically weighted regression analysis of environmental health justice. Popul Environ. :1–22.

50. Grineski SE, Collins TW, Chavez-Payan P, et al. Social disparities in children's respiratory health in el paso, texas. International journal of environmental research and public health. 2014; 11(3): 2941–2957. [PubMed: 24619157]

51. Balcazar AJ, Grineski SE, Collins TW. The durability of immigration-related barriers to health care access for hispanics across generations. Hispanic Journal of Behavioral Sciences. 2015; 37(1): 118–135.

52. Balcazar A, Grineski S, Collins T. The hispanic health paradox across generations: The relationship of child generational status and citizenship with respiratory health outcomes. Public Health. 2015

53. Chavez-Payan P, Grineski S, Collins T. Low birth weight, prenatal smoking, breastfeeding and pest exposure modify the effect of acculturation on hispanic children's asthma. hispanic health care international. 13(3)Hispanic Health Care International. 2015; 13(3)

54. Curtin R, Presser S, Singer E. The effects of response rate changes on the index of consumer sentiment. Public Opin Q. 2000; 64(4):413–428. [PubMed: 11171024]

55. Groves RM. Nonresponse rates and nonresponse bias in household surveys. Public Opin Q. 2006; 70(5):646–675.

56. Holbrook A, Krosnick JA, Pfent A. The causes and consequences of response rates in surveys by the news media and government contractor survey research firms. Advances in telephone survey methodology. 2007:499–528.

57. Keeter S, Kennedy C, Dimock M, Best J, Craighill P. Gauging the impact of growing nonresponse on estimates from a national RDD telephone survey. Public Opin Q. 2006; 70(5):759–779.

58. Visser PS, Krosnick JA, Marquette J, Curtin M. Mail surveys for election forecasting? an evaluation of the columbus dispatch poll. Public Opin Q. 1996; 60(2):181–227.

59. EPISD. [Accessed February 19 2014, 2014] District information. http://www.espid.org/_district. Updated 2013

60. Asher MI, Keil U, Anderson HR, et al. International study of asthma and allergies in childhood (ISAAC): Rationale and methods. Eur Respir J. 1995; 8(3):483–491. [PubMed: 7789502]

61. Jenkins MA, Clarke JR, Carlin JB, et al. Validation of questionnaire and bronchial hyperresponsiveness against respiratory physician assessment in the diagnosis of asthma. Int J Epidemiol. 1996; 25(3):609–616. [PubMed: 8671563]

62. Annesi-Maesano I, Sterlin C, Caillaud D, et al. Factors related to under-diagnosis and under-treatment of childhood asthma in metropolitan france. Multidiscip Resp Med. 2012; 7(1):24.

63. Eldeirawi K, McConnell R, Freels S, Persky VW. Associations of place of birth with asthma and wheezing in mexican american children. J Allergy Clin Immunol. 2005; 116(1):42–48. [PubMed: 15990771]

64. Mendoza RH. An empirical scale to measure type and degree of acculturation in mexican american adolescents and adults. Journal of Cross-Cultural Psychology. 1989; 20(4):372–385.

65. Mendoza, R. Cultural life style inventory: Version 20. Los Angeles, CA: California School of Professional Psychology; 1994.

66. Lerman D, Maldonado R, Luna D. A theory-based measure of acculturation: The shortened cultural life style inventory. Journal of Business Research. 2009; 62(4):399–406.

67. Magaña JR, de la Rocha O, Amsel J, Magafia HA, Fernandez MI, Rulnick S. Revisiting the dimensions of acculturation: Cultural theory and psychometric practice. Hispanic Journal of Behavioral Sciences. 1996; 18(4):444–468.

68. Clark BR, Burkett SA, Andridge RR, Buckley TJ. Evidence of high rates of undiagnosed asthma in central ohio elementary schoolchildren. J Sch Health. 2013; 83(12):896–906. [PubMed: 24261524]

69. Camacho-Rivera M, Kawachi I, Bennett GG, Subramanian S. Revisiting the hispanic health paradox: The relative contributions of nativity, country of origin, and race/ethnicity to childhood asthma. Journal of Immigrant and Minority Health. 2014:1–8. [PubMed: 23054547]

70. Javier JR, Wise PH, Mendoza FS. The relationship of immigrant status with access, utilization, and health status for children with asthma. Ambulatory Pediatrics. 2007; 7(6):421–430. [PubMed: 17996835]

71. Iqbal S, Oraka E, Chew GL, Flanders WD. Association between birthplace and current asthma: The role of environment and acculturation. Am J Public Health. 2014; 104(S1):S175–S182. [PubMed: 24354818]

72. Shalowitz MU, Sadowski LM, Kumar R, Weiss KB, Shannon JJ. Asthma burden in a citywide, diverse sample of elementary schoolchildren in chicago. Ambulatory Pediatrics. 2007; 7(4):271–277. [PubMed: 17660097]

73. Kawachi I, Daniels N, Robinson DE. Health disparities by race and class: Why both matter. Health Aff (Millwood). 2005; 24(2):343–352. [PubMed: 15757918]

**Table 1**

Characteristics of the Study Population

|  | N=1305 | Mean (± SD) Or % | % Missing |
|---|---|---|---|
| Age (range: 9–13) | 1265 | 10.38 (±0.77) | 3.06 |
| Gender (Male) | 1263 | 48% | 3.2 |
| Child's History of Allergies | 1276 | 49% | 2.2 |
| ***Unidimensional Measures*** | | | |
| Nativity (US-born) | 1301 | 91% | 0.31 |
| Survey Language (English) | 1305 | 55% | 0 |
| ***Multidimensional Measure (CLSI)*** | | | |
| Child Acculturation CLSI Category | 1304 | | 7.7 |
| Segregated | 328 | 27% | |
| Integrated | 173 | 14% | |
| Assimilated | 704 | 58% | |
| ***Health Care System Domain*** | | | |
| Continuous Insurance Coverage | 1281 | 83% | 1.8 |
| Child has Doctor for Routine Care | 1280 | 90% | 1.9 |
| Family Postpones Care Due to Cost | 1294 | 27% | 0.8 |
| ***Disparities Domain*** | 1251 | | 4.1 |
| No Wheezing/Asthma Symptoms | 947 | 76% | |
| Possible Undiagnosed Asthma | 115 | 9% | |
| Diagnosed Asthma | 189 | 15% | |
| Total Asthma Burden | 304 | 24% | |

Notes

[a]The mean for dichotomous variables above can be interpreted as proportions. For instance, the mean for total asthma burden (where 0=no asthma symptoms/wheezing, and 1=possible undiagnosed asthma and diagnosed asthma combined) indicates that 24% of students in this sample are experiencing respiratory distress.

**Table 2**

Bivariate Associations between Child's Characteristics and Asthma Status

|  | No asthma/symptoms in the last year | Possible Undiagnosed Asthma | Diagnosed Asthma |
|---|---|---|---|
| Age | (10.40 ± .78) | (10.26 ± .84) | (10.38 ± .72) |
| Gender, N (%) |  |  |  |
| Girls | 504 (55%) | 51 (45%) | 74 (41%) |
| Boys | 417 (45%) | 62 (55%) | 108 (59%) |
| $x^2$=14.43 p = 0.001 |  |  |  |
| History of Allergies, N (%) |  |  |  |
| No | 560 (60%) | 27 (24%) | 34 (18%) |
| Yes | 378 (40%) | 86 (76%) | 151 (82%) |
| $x^2$=140.01 p < 0.001 |  |  |  |
| Child's Nativity |  |  |  |
| Foreign-born | 99 (11%) | 8 (7%) | 7 (4%) |
| US-born | 846 (89%) | 107 (93%) | 181 (96%) |
| $x^2$=9.53 p = 0.008 |  |  |  |
| Survey Language |  |  |  |
| Spanish | 444 (47%) | 36 (31%) | 67 (35%) |
| English | 503 (53%) | 79 (69%) | 122 (65%) |
| $x^2$=16.33 p < 0.001 |  |  |  |
| CLSI Acculturation Category |  |  |  |
| Segregated | 260 (30%) | 18 (17%) | 32 (18%) |
| Integrated | 126 (14%) | 15 (14%) | 19 (11%) |
| Assimilated | 488 (56%) | 74 (69%) | 129 (72%) |
| $x^2$= 22.46 p < 0.001 |  |  |  |
| Continuous Insurance Coverage, N (%) |  |  |  |
| No | 171 (18%) | 18 (16) | 18 (10) |
| Yes | 762 (82%) | 96 (84) | 167 (90) |
| $x^2$= 8.37 p = 0.01 |  |  |  |
| Child has Doctor for Routine Care |  |  |  |
| No | 101 (11%) | 12 (10%) | 5 (3%) |
| Yes | 832 (89%) | 103 (90%) | 178 (98%) |
| Fisher's exact = 0.001 |  |  |  |
| Family Postpones Care Due to Cost |  |  |  |
| No | 696 (74%) | 73 (63%) | 130 (70%) |
| Yes | 246 (26%) | 42 (37%) | 55 (30%) |
| $x^2$=13.33 p = 0.05 |  |  |  |

**Table 3**

Multivariate Regression Models of Child's Asthma Status by Measures of Acculturation (using no wheezing/asthma symptoms as referent group)

|  | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| **Possible Undiagnosed Asthma** |  |  |  |  |
| Gender (male) | 1.47 | 1.46 | 1.47 | 1.48 |
| History of Allergies | 4.68[**] | 4.67[**] | 4.21[**] | 4.37[**] |
| Insurance Coverage | 1.31 | 1.30 | 1.31 | 1.34 |
| Child has Doctor for Routine Care | 0.89 | 0.88 | 0.79 | 0.82 |
| Family Postpones Care Due to Cost | 2.07[**] | 2.07[**] | 2.08[**] | 2.07[**] |
| Nativity (US-born) |  | 1.04 |  |  |
| Language (English) |  |  | 1.58 |  |
| Acculturation |  |  |  |  |
| Segregated (reference) |  |  |  |  |
| Integrated |  |  |  | 1.59 |
| Assimilated |  |  |  | 1.60 |
| **Diagnosed Asthma** |  |  |  |  |
| Gender (male) | 1.79[**] | 1.77[**] | 1.79[**] | 1.79[**] |
| History of Allergies | 6.67[**] | 6.59[**] | 6.66[**] | 6.17[**] |
| Insurance Coverage | 1.61 | 1.57 | 1.6 | 1.65 |
| Child has Doctor for Routine Care | 3.11[*] | 2.88 | 3.10[*] | 2.84 |
| Family Postpones Care Due to Cost | 1.71[*] | 1.73[**] | 1.70[*] | 1.70[*] |
| Nativity (US-born) |  | 1.51 |  |  |
| Language (English) |  |  | 1.01 |  |
| Acculturation |  |  |  |  |
| Segregated (reference) |  |  |  |  |
| Integrated |  |  |  | 1.22 |
| Assimilated |  |  |  | 1.55 |
| **Fit Statistics** |  |  |  |  |
| Log-likelihood | −709.27 | −708.84 | −707.49 | −706.47 |
| df | 10 | 12 | 12 | 14 |
| chi2 | 167.8 | 168.65 | 171.37 | 173.4 |
| Likelihood-ratio test |  | 0.65 | 0.16 | 0.26 |

Notes: complete case analysis n=1,095; statistical significance:

[*] p<0.05;

[**] p<.01